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Active transport, physical activity, and body weight in adults: a systematic review

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Abstract: CONTEXT: Physical activity has various health benefits. Active transport can contribute to total physical activity and thus affect body weight because of increased energy expenditure. This review summarizes published evidence on associations of active transport, general physical activity, and body weight in adults. EVIDENCE ACQUISITION: A systematic review of the literature was conducted in October 2010 using eight databases. A total of 14,216 references were screened; full texts were retrieved for 95 articles. Forty-six articles (36 unique studies) were included: 20 (17) from Europe; 18 (13) from North America, Australia, and New Zealand; and eight (six) from other countries. Analyses of the retrieved papers were carried out between November 2010 and March 2011. EVIDENCE SYNTHESIS: Of 15 studies assessing active transport and physical activity, five found associations in the expected direction (more active transport associated with more physical activity) for all or most variables studied, nine found some associations, and one reported no associations. Of 30 studies assessing active transport and body weight, 13 reported associations in the expected direction (more active transport associated with lower body weight) for all or most variables studied, 12 found some associations, two presented some associations in the expected and some in the opposite direction, and three reported no associations. CONCLUSIONS: There is limited evidence that active transport is associated with more physical activity as well as lower body weight in adults. However, study heterogeneity, predominantly cross-sectional designs, and crude measures for active transport and physical activity impede quantitative conclusions.

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Active Transport, Physical Activity Levels and Body Weight in Adults

A Systematic Review

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Context: Physical activity has various health benefits. Active transport can contribute to total physical activity and thus affect body weight due to increased energy expenditure. This review summarizes published evidence on associations between active transport, general physical activity and body weight in adults.

Evidence acquisition: A systematic review of the literature was conducted in October 2010 using eight databases. 14,216 references were screened; full texts were retrieved for 95 articles. Forty-six articles (36 unique studies) were included: 20 papers (17 studies) from Europe, 18 (13) from North America, Australia and New Zealand and 8 (6) from other countries. Analyses of the retrieved papers were carried out between November 2010 and March 2011.

Evidence synthesis: Out of 15 studies assessing active transport and physical activity, 5 found exclusively or mostly significant associations in the expected direction (more active transport associated with more physical activity), 9 studies found some significant associations and 1 study did not report significant associations. Out of 30 studies assessing active transport and body weight, 13 reported exclusively or mostly significant associations in the expected direction (more active transport associated with lower body weight), 12 found some significant associations, 2 presented some significant associations in the expected and some in the opposite direction and 3 did not report significant associations.

Conclusions: There is limited evidence that active transport is associated with more physical activity as well as lower body weight in adults. However, study heterogeneity, predominantly cross-sectional designs and crude measures for active transport and physical activity impede quantitative conclusions.

Introduction

The health benefits of physical activity are well documented in the literature.[1] Active transport as a form of physical activity may contribute considerably to total physical activity and could therefore have significant positive health effects.[2-4] Furthermore, active transport and especially walking is feasible for most individuals.

Several positive health effects of overall walking (during leisure time and for commuting purposes) and active transport specifically have been demonstrated: Overall walking was inversely associated with cardiovascular risk factors and all-cause mortality in a meta-analysis of prospective cohort studies.[5] A review of observational studies supports evidence that non-commuting walking reduces the risk of cardiovascular disease.[6] Focusing specifically on active transport, a meta-analysis showed that walking and cycling were associated with an 11% risk reduction for cardiovascular outcomes.[7] In two longitudinal studies, individuals cycling to work had an about 30% reduced risk of dying.[8 9] There is also some evidence of positive effects regarding active transport and the risk of colon[10] and endometrial cancer.[11]

A rise in the prevalence of overweight and obesity during the last years is of great concern for public health. For prevention purposes it is important to identify factors that may help to keep a healthy body weight. There is some evidence that regular physical activity has a positive effect on body weight.[1] A longitudinal study in the U.S. showed a significantly higher probability of losing weight in individuals walking at least 2 hours per week.[12] Moreover, a meta-analysis of walking intervention trials has reported significant effects on body weight.[13]

Regarding active transport specifically, ecological studies have reported associations between levels of active transport and levels of overweight/obesity and general physical activity at the population level:[14-16] Bassett et al. showed that countries with the highest levels of active transport generally had the lowest obesity rates.[14] Similarly, Pucher et al. reported significant negative correlations between active transport and self-reported obesity at the country, state and city level.[15] Furthermore, there were significant positive correlations between active transport and overall physical activity at the state and city level.[15] According to Smith et al., doubling the proportion of neighborhood residents walking to work decreased the risk of an individual to be obese by almost 10%.[16]

In children and adolescents, two systematic reviews on active transport to school, physical activity levels and body weight were published in 2008 and 2009.[17 18] Lee et al.[17] included 32 studies published up to 2007, indicating a positive association between active transport to school and general physical activity, but no evidence for an association between active transport and body weight. Faulkner et al.[18] only included studies that used objective measures of physical activity and body weight, identifying 13 relevant studies published up to 2008. Their conclusions were very similar, supporting evidence for higher walking and cycling to school activity leading to higher physical activity levels, but not supporting evidence for an effect on body weight.[18] Recently, a review has been published on the relationship between active transport to school and health-related fitness in children and adolescents,[19] also including body weight. In about half of the studies, active transport was associated with a more beneficial weight status.[19]

To our knowledge, so far no review on active transport, physical activity and body weight in adults has been published. This systematic review addresses the following research questions:

(1) Is there an association between active transport and general physical activity in adults? (2) Is there an association between active transport and body weight in adults?

Evidence Acquisition

Identification of relevant studies

A systematic review of the literature was conducted to identify relevant studies published up to October 2010. The search was carried out by an epidemiologist based on a consultation with a scientific librarian of the University of Zurich, Switzerland in October 2010. The following databases were searched: Medline, Web of Science, Embase, SportDiscus, PsycINFO, Cinahl, TRIS Online National Transport Library and Cochrane Library.

The search strategy involved a combination of the following three sets of key words (adapted from Lee et al.[17]):

1) active commut* or active transport* or active travel* or non-motori*ed or bik* or bicyl* or cycl* or walk*

AND

2) physical activity or body weight or overweight or obese or obesity or body mass index or BMI or exercise

AND

3) adult*

Because the search yielded a high number of references from (cell)biological research that contained key words such as "cell cycle", a further set of key words was used to exclude such references:

4) NOT (biological transport or substrate cycling or Amikacin or chromosome walking or Dandy-Walker Syndrome or therapy or physiology or ergomet* or exercise test or treadmill or gait or cell).

To be included, studies had (1) to report a measure of active transportation, (2) to report a measure of general physical activity (e.g. total physical activity, leisure-time physical activity) or of weight (e.g., BMI, waist circumference), (3) to present a quantitative association between active transport and physical activity or active transport and weight at the individual level (no ecological studies), (4) to focus on adults, (5) to be published in English, German or French, (6) to be published in a peer-reviewed journal (no conference proceedings and abstracts). Only one study was excluded due to language restriction (in Japanese[20]). Preliminary results and pilot studies were excluded.

The searches produced 17,133 references of which 2917 were duplicates. The remaining 14,216 references were screened for relevance based on title and/or abstract by one author (MW) and a random sub sample of 5% of the references cross-checked by a second author (TG). The study selection process is displayed in Figure 1. For 85 articles, the full text was retrieved and considered for inclusion by two authors (MW and TG). Eleven additional references were identified through hand-searching of the reference lists of relevant articles. Finally, 46 articles representing 36 unique studies were included: 20 papers (17 unique studies) from Europe, 18 (13) from North America, Australia, and New Zealand, and 8 (6) from other countries. Analyses of the retrieved papers were carried out between November 2010 and March 2011.

Data Extraction

For each of the included studies, information was extracted on: study design, study place and year, sample size (% men and women), age range (or mean age when range not available), sampling method, measure(s) of active transport, measure(s) of physical activity, measure(s) of body weight, the statistical analyses used, the significance level of the reported associations of interest for unadjusted and adjusted analyses (active transport and general physical activity, active transport and body weight) as well as potential confounders that multivariate analyses were adjusted for (see Appendix A, www.ajpmonline.org). Significance level was set at $p<0.05$ except in one study[21] that reported 99% confidence intervals and one study[22] that reported 90% confidence intervals.

Quality assessment of the studies

Two of the reviews in children and adolescents on transport to school, physical activity and body weight did not address the aspect of quality of the included studies,[17 18] while the third one developed an assessment tool based on the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) statement.[19] The quality assessment in the present review was adapted from that tool. The quality criteria and specification of scores are displayed in Table 1. A total score of 10 could be attained. The articles were rated separately for assessing the association between active transport and general physical activity and the association between active transport and body weight in order to account for the different outcomes and their measurement methods (3a and 3b in Table 1).

Evidence Synthesis

Description and quality of studies

The 46 included articles were published between 1993 and 2010, with 12 published before 2005, 18 between 2005 and 2008, and 16 between 2009 and 2010. All studies were cross-sectional except one longitudinal study conducted in France and Northern Ireland.[23 24] Eight of the 46 articles (6 of 36 studies) reported associations between active transport and general physical activity, 29 articles (21 studies) reported associations between active transport and body weight, and 9 articles (9 studies) reported both associations. The individual articles are described in Appendix A.

Assessment of active transport was based on self-report instruments (questionnaires, interviews) in all studies. 24 articles reported total active transport, 16 active commuting to work or school, 2 active transport for other purposes than to work/school and 4 total active transport but separately to work/school and for other purposes. While 6 publications included only walking as active transport and 4 only cycling, 31 included walking and cycling combined and another 5 reported walking and cycling separately. Seven publications presented active transport in a continuous manner, 16 used a categorical variable for active transport and 23 articles reported active transport as a dichotomous variable (yes/no).

Only two studies used objective and validated methods to assess physical activity (one in combination with a validated questionnaire), while 13 studies used self-report instruments (questionnaires, interviews), of which 5 were mentioned to be validated. Regarding body weight as an outcome, weight, height and/or other measures of weight status were assessed objectively in 14 studies while 16 studies used self-report methods.

Most studies included adults over a wide age range such as 18+ years, 25-64 years etc. Only few studies focused on specific age groups such as 50-70 years,[25 26] young adults aged 18-28 years,[27] or over than 65 year-olds.[28]

Quality rating for the articles reporting an association between active transport and physical activity resulted in a mean score of 3.7 out of 10 (median 4, minimum 2,[27 29], maximum 5[30-32]). These relatively low total scores were mainly due to crude measures of active transport (walking and cycling combined, dichotomous) and physical activity (mostly self-report, not always validated). The mean quality score of the articles reporting an association between active transport and body weight was 4.7 out of 10 (median 4.0, minimum 2[33], maximum 8[34]). Again, crude measures of active transport were responsible for low quality scores, however about half of the studies assessed the outcome (body weight) objectively obtaining higher average scores for this criterion compared to articles reporting an association between active transport and general physical activity.

The individual scores for each included article can be found in Appendix B (www.ajpmonline.org) (outcome physical activity) and Appendix C (outcome body weight). The total scores for each paper are reported in Appendix A.

Association between active transport and physical activity

A summary of the associations on active transport and general physical activity is displayed in Table 2 (results and description of the individual articles see Appendix A). The vast majority of studies observed associations in the expected direction: 5 of 15 studies reported exclusively or mostly significant associations in the expected direction (more active transport associated with more general physical activity)[25-27 30 35-37] and 9 studies reported some significant associations in the expected direction and some non-significant associations.[22 29 31 32 38-42] One study did not report any significant associations between active transport and physical activity.[43] Considering only the results of objective measures of physical activity used in 2 of the studies, both reported some significant associations in the expected direction and some non-significant associations.[22 30] By region, the proportion of studies reporting at least some significant associations was between 80% (Europe) and 100% (North America and Oceania, other countries). The proportion of studies reporting exclusively or mostly significant associations was higher for studies from North America and Oceania (43%) than from Europe (20%) and from other countries (33%).

There is no clear pattern regarding the quality scores of the articles and the reported associations. This may also be due to the fact that most studies scored rather poorly (no studies on active transport and physical activity had a quality score higher than 5). Of the two articles with the lowest quality score (=2), one reported mostly significant associations in the expected direction,[27] and the other reported some significant associations in the expected direction and some non-significant associations(Table 2).[29] Of the three articles with the highest quality score (=5), one reported mostly significant associations in the expected direction,[30] and two reported some significant associations in the expected and some non-significant associations.[31 32] Those articles reporting exclusively significant associations in the expected direction all attained a quality score of 3.[25 26 35]

Association between active transport and body weight

An overview of the associations on active transport and body weight is shown in Table 2 (results and description of the individual articles see Appendix A). Twenty-five of the 30 studies observed an inverse association between active transport and body weight. Thirteen of

30 studies reported exclusively or mostly significant associations in the expected direction (more active transport associated with lower body weight).[23 24 28 34 39 44-54] Twelve studies reported some significant associations in the expected direction and some non-significant associations.[25-27 30 31 35 38 40 55-62] Two studies reported some significant associations in the expected direction, but also some significant associations in the other direction (more active transport associated with higher body weight).[21 63 64] Three studies did not report any significant associations between active transport and body weight.[33 65 66] By region, the proportion of studies reporting at least some significant associations was between 75% (other countries) and 91% (North America and Oceania). The proportion of studies reporting exclusively or mostly significant associations was higher for studies from Europe (57%) than from North America and Oceania (27%) and from other countries (25%).

Studies reporting significant associations in the expected direction used both self-reported and objectively measured body weight variables. All studies reporting no significant associations had used self-report measures.

The publications reporting odds ratios (OR) for overweight (n=9) or obesity (n=7) based on different levels of active transport are summarized in Figure 2 and Figure 3, separately for men, women and combining both genders. The OR for the highest category of active transport was used if the variable was categorical with more than two categories.

In some studies, the number of women cycling for transport was very low resulting in large confidence intervals or impossibility to analyze this subgroup.[58] Some studies reported significant associations only for men, others only for women with no systematic pattern in favor of one gender. This is also supported by Figures 2 and 3 where results are stratified by gender.

Again, no pattern emerged regarding the quality scores of the articles and the associations they reported. Both articles with lower (=2–3) and higher (=6-8) quality scores were represented in different categories of associations as displayed in Table 2. The article with the lowest quality score (=2) reported no significant associations.[33] Of the three articles with the highest quality scores (=7–8 out of 10), one reported exclusively significant associations[23] and one mostly significant associations in the expected direction,[34] the third reported some significant and some non-significant associations.[55] Those studies reporting exclusively significant associations in the expected direction attained quality scores between 3 and 7. The only longitudinal study[23] reported exclusively significant associations in the expected direction both for cross-sectional (baseline) and longitudinal analyses and attained a quality score of 6.

The association between active transport and body weight may be confounded by other forms of physical activity. Of the 13 studies reporting mostly or exclusively significant results, five adjusted for some form of other physical activity (leisure-time and/or occupational activity, meeting the physical activity guidelines). Of the 12 studies reporting some significant associations, eight controlled for some form of physical activity (leisure-time, occupational physical activity, current sporting activity, physical activity other than walking, physical activity level). Of the three studies reporting no significant associations, one controlled for leisure-time physical activity.

Discussion

According to mainly cross-sectional studies, there is evidence of associations between active transport and higher general physical activity levels and active transport and lower body weight: 93% of studies investigating the association between active transport and general physical activity and 83% of studies investigating the association between active transport and body weight reported at least some significant associations in the expected direction. Due to the heterogeneity of the studies, it was not possible to combine the results in a quantitative summary estimate and therefore the results were presented in a descriptive manner.

Regarding active transport and body weight, Figure 2 shows that most ORs were below 1 with several of their confidence intervals excluding 1, indicating that there may be an association in the expected direction (more active transport associated with lower body weight). Moreover, different reasons may be responsible for "non-significant" results: While a real lack of an association is one possible explanation, others include a lack of statistical power (sample size too small) or imprecise measures of exposure (active transport) or outcome (physical activity, body weight). This was the case in many of the analyzed studies (see below), and may lead to a bias towards the null.

Despite the consistent associations in the reviewed studies, several limitations of the existing evidence need to be taken into account, hampering the interpretation of the results and preventing us from drawing strong conclusions. The first limitation is related to the study design: all but one of the studies were cross-sectional. Therefore it is not possible to infer causality and the direction of the association: Does active transport contribute to higher amounts of physical activity (causality), or are physically active individuals more likely to use active transport (reverse causality)? Does active transport contribute to a lower BMI due to higher energy expenditure (causality), or are lean individuals more likely to walk or cycle for transport purposes than overweight individuals (reverse causality)? Both directions seem plausible: Physical activity is associated with higher energy expenditure and severe obesity may limit physical activities. Scientific evidence is also available for both hypotheses from analyses that did not specifically focus on walking and cycling for transport purposes. In a meta-analysis of walking intervention trials, significantly better effects on body weight were seen in the intervention compared to the control groups.[13] Furthermore, in three longitudinal studies, a significantly higher probability of losing weight over 15 years was reported in individuals walking at least 2 hours per week,[12] a significantly lower weight gain over 16 years was reported in women increasing their physical activities by 30 minutes per day,[67] and a significantly lower weight gain was reported in individuals maintaining a higher activity level over 20 years compared to those maintaining a lower activity level.[68] On the other hand, a longitudinal study indicated that overweight individuals may be less physically active,[69] and an experimental study showed that walking decreased in previously lean individuals when their body weight increased.[70]

A second important limitation of the included studies was the crude methods of assessing active transport based exclusively on self-report instruments since no routine tools exist yet for objective assessments. In addition, the definition of “active transport” differed, with some studies including all trips (combined or separately to work and for other purposes) and other studies investigating only commuting to work or only active transport for other purposes. Furthermore, some studies reported simple dichotomized variables (“yes” for any active transport), some studies differentiated between walking and cycling, while others reported the detailed number of minutes spent in different forms of active transport. Overall, the assessment of active transport as exposure was probably associated with a relatively high degree of imprecision in most studies, thus limiting the detection of significant relationships with outcome variables such as body weight. The crude measures for active transport also impede comparisons between studies and analyses regarding different exposure groups within studies. On the other hand, more detailed assessment tools such as travel diaries are associated with high participant burden, which may also have an impact on the selection of participants and on data quality. Furthermore, inconsistencies in defining a journey and in handling mixed travel modes complicate comparisons between studies.

Further limitations pertain to the measurements of general physical activity and body weight. Only two studies used objective and validated methods to assess general physical activity, 13 studies used self-report instruments which are known to have limitations such as recall bias.[71] A variety of questionnaires were used and different activity summary measures presented. Furthermore, only few of the self-report instruments were validated. Regarding body weight, in only about half of the studies objective measures were taken. Tendencies of underreporting body weight[72] may lead to underestimation of the association between active transport and body weight. However it does not seem that there were systematic differences in the findings based on the methods used to assess body weight.

In general, the above mentioned limitations were responsible for relatively low quality scores of most of the included studies. However, there was no obvious difference in reporting significant associations based on the quality of the studies. Furthermore, only about half of the studies assessing the association between active travel and body weight controlled for other forms of physical activity. However, this did not seem to have a systematic impact on the association of interest (i.e. studies controlling for other forms of physical activity being more likely to report no association).

Consistent evidence was found that children who walk or cycle to school show significantly higher levels of physical activity[17 18] but evidence for an association between active transport to school and lower body weight was not compelling in the two earlier reviews.[17 18] Similarly, Lubans et al.[19] found that only about half of the studies examining the association between active transport to school and body weight reported significant results. These findings are in contrast to the results of the present review in adults indicating that there may be an association between active transport and lower body weight. It is not clear why the results differ for adults and children. While in children, weight variables were mostly assessed objectively, half of the studies in adults used self-reported weight measures. However, this does not seem to be a reason for the different conclusions since "exclusively" and "mostly significant" associations (see Table 2) in adult studies were reported evenly in studies using objective and self-report instruments. Differences also exist regarding the choices of transport modes in children and adults (i.e. children cannot choose to drive). However, the findings of our review in adults are in line with results published on the positive effects of overall walking on body weight in adults.[12 13]

A limitation of the present review may be that the search strategy was restricted to published studies and therefore publication bias may be a problem in that studies with non-significant results were less likely to be published. However, the focus of several studies was not directly on the associations of interest for this review, therefore it is unlikely that studies reporting non-significant results on these associations were not published. Furthermore, no adequate standard quality assessment tool was found. Therefore the scoring used in this review was based on a tool used in one of the children's reviews.[19] The tool may only be able to roughly judge the quality of the included studies. However, changing the weights of the individual quality items did not change the overall results. Furthermore, the level of evidence found in a systematic review is not necessarily associated with the quality of the studies. Even good quality cross-sectional studies do not allow conclusions regarding causality. However, grading of evidence, as for example suggested by De Bourdeaudhuij et al. (2011)[73], did not make sense in this review as almost all studies were cross-sectional and randomized controlled trials are not feasible in this field of research.

Despite these limitations, to our knowledge, this is the first systematic review on associations between active transport, general physical activity and body weight in adults. It includes a large number of studies representing different parts of the world. In order to further explore causal relationships between active transport, physical activity and body weight, more research is needed using a longitudinal study design and improved measurement methods (validated or ideally objective measures of physical activity and body weight, more detailed assessment of active transport, ideally based on the development of new and improved methods, including objective measures). For example, the efficacy of a new electronic measurement device for assessing active transport, a wearable digital camera, has been tested in a pilot study showing considerable potential for future research.[74] Finally, studies should consistently control for other forms of physical activity in order to assess the independent effect of active travel.

Conclusions

According to evidence from cross-sectional studies, active transport is associated with higher general physical activity levels and lower body weight in adults. Considering the diverse other positive health effects of active transport,[7 8 10 11] this kind of physical activity behavior has potential to contribute significantly to public health improvements at the population level, especially because it is amenable to most people, given that safe environments for active transport are becoming more available, as recommended by WHO and other international bodies.[75 76] However, the quality of the included studies limits final conclusions, and more longitudinal studies using more detailed and ideally objective measures of active transport, physical activity and body weight are needed to explore the causal nature of the associations further.

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List of Figures

Figure 1. Study selection process

Figure 2. Summary of odds ratios from publications reporting an association between active transport and overweight and obesity (BMI≥25).

* only those living <2miles from work

C, cycling; W, walking

Figure 3. Summary of Odds Ratios from publications reporting an association between active transport and obesity (BMI≥30).

C, cycling; W, walking

Table 1. Quality criteria and specification of scores

Quality criteria	Specification of scores	Score
1) Study type	Cross-sectional	0
	Longitudinal	1
2) Assessment of exposure (active transport)	Walking and cycling combined, dichotomous	0
	Walking and cycling combined, categorical	1
	Walking and cycling combined, continuous	2
	Walking and cycling separate, dichotomous	1
	Walking and cycling separate, categorical	2
	Walking and cycling separate, continuous	3
3a) Assessment of physical activity as outcome	Self-reported, not validated	0
	Self-reported, validated[a)]	1
	Objectively measure[b)], not validated	1
	Objectively measured, validated	2
3b) Assessment of body weight as outcome	Self-reported	0
	Objectively measured[c)]	2
4) Sample size	Too small for meaningful results (<500)	0
	500-10,000	1
	>10,000	2
5) Completeness of data	Data available for <80% of participants or not reported	0
	Data available for ≥80% of participants	1
6) Control for confounding	Not controlled for confounders	0
	Controlled at least for gender, age and some proxy of SES (e.g. income, education, etc.)	1
Total Score	**Minimum**	**0**
	Maximum	**10**

Notes: [a)] validated: validity of the instrument was examined against another measure of physical activity

[b)] An objective measure of physical activity was used, such as pedometers or accelerometers

[c)] Physical measures (height, weight etc.) were taken objectively

Table 2. Summary of studies on active transport, physical activity and body weight in adults, according to statistical association

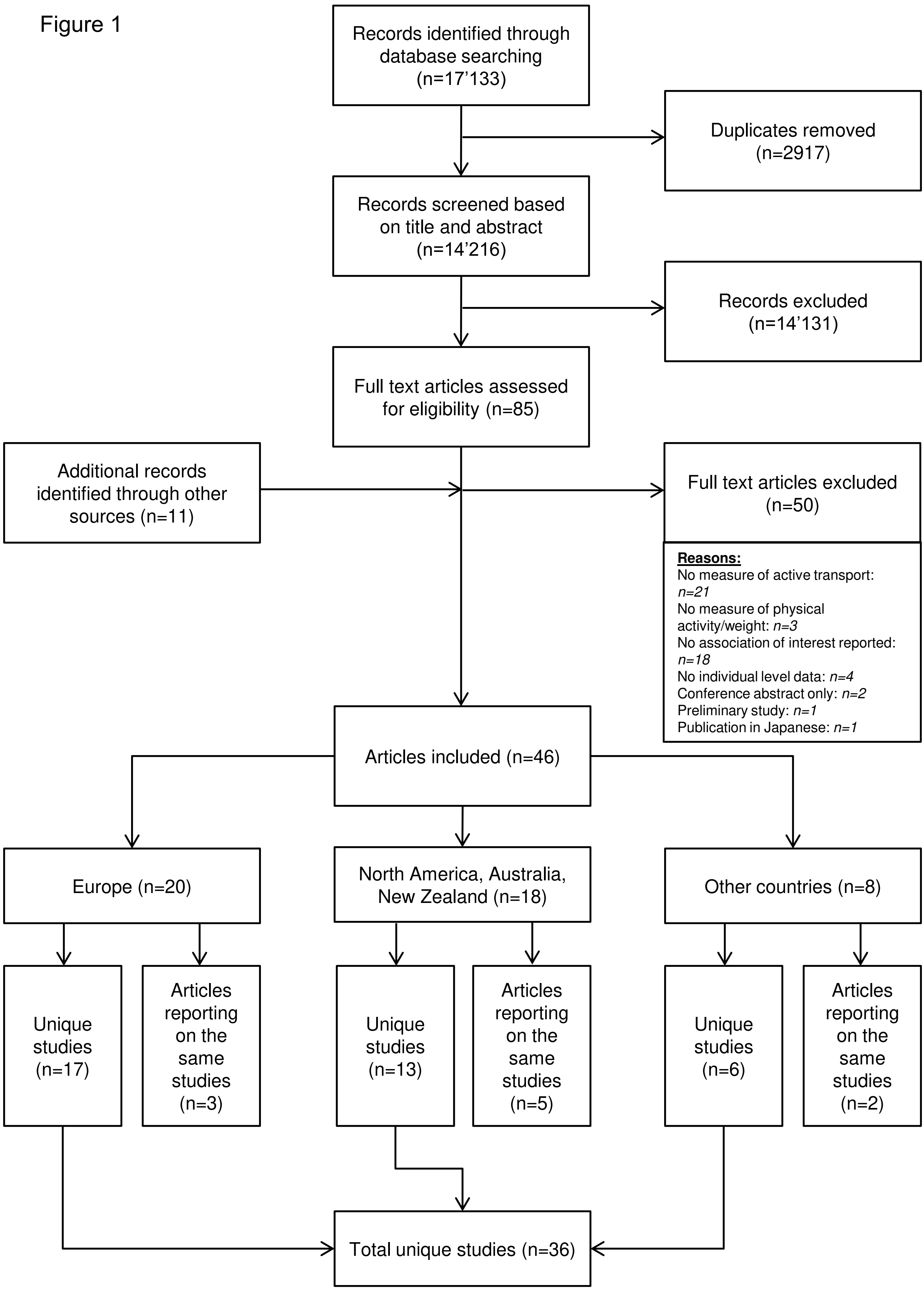
	Higher active transport and higher general physical activity				**Higher active transport and lower body weight**			
	Europe	NA, OC	Other countries[a]	**Total**	Europe	NA, OC	Other countries[a]	**Total**
Exclusively significant associations in expected direction	1	1	0	**2**	6	1	0	**7**
Mostly significant associations in expected direction, few non-significant associations	0	2	1	**3**	3	2	1	**6**
Some significant associations in expected direction, some non-significant associations	3	4	2	**9**	3	7	2	**12**
Some significant associations in expected direction, some significant associations in *other* than expected direction	0	0	0	**0**	1	0	1	**2**
No significant associations	1	0	0	**1**	2	1	0	**3**
Total	**5**	**7**	**3**	**15**	**15**	**11**	**4**	**30**

Note: Results presented on study level, not article level (i.e. the results of the same study published in different articles were combined). Exclusively significant associations: all reported associations in the study were significant; mostly significant associations: more than 50% of the reported associations in the study were significant; some significant associations: less than 50% of the reported associations in the study were significant; no significant associations: all reported associations were not significant.

[a] Other countries include Brazil, China, Colombia and Nigeria

NA, North America and Canada; OC, Oceania (Australia, New Zealand)

Figure 1



Records identified through database searching (n=17'133)
Duplicates removed (n=2917)
Records screened based on title and abstract (n=14'216)
Records excluded (n=14'131)
Full text articles assessed for eligibility (n=85)
Additional records identified through other sources (n=11)
Full text articles excluded (n=50)
Reasons:
No measure of active transport: n=21
No measure of physical activity/weight: n=3
No association of interest reported: n=18
No individual level data: n=4
Conference abstract only: n=2
Preliminary study: n=1
Publication in Japanese: n=1
Articles included (n=46)
Europe (n=20)
North America, Australia, New Zealand (n=18)
Other countries (n=8)
Unique studies (n=17)
Articles reporting on the same studies (n=3)
Unique studies (n=13)
Articles reporting on the same studies (n=5)
Unique studies (n=6)
Articles reporting on the same studies (n=2)
Total unique studies (n=36)

Figure 2

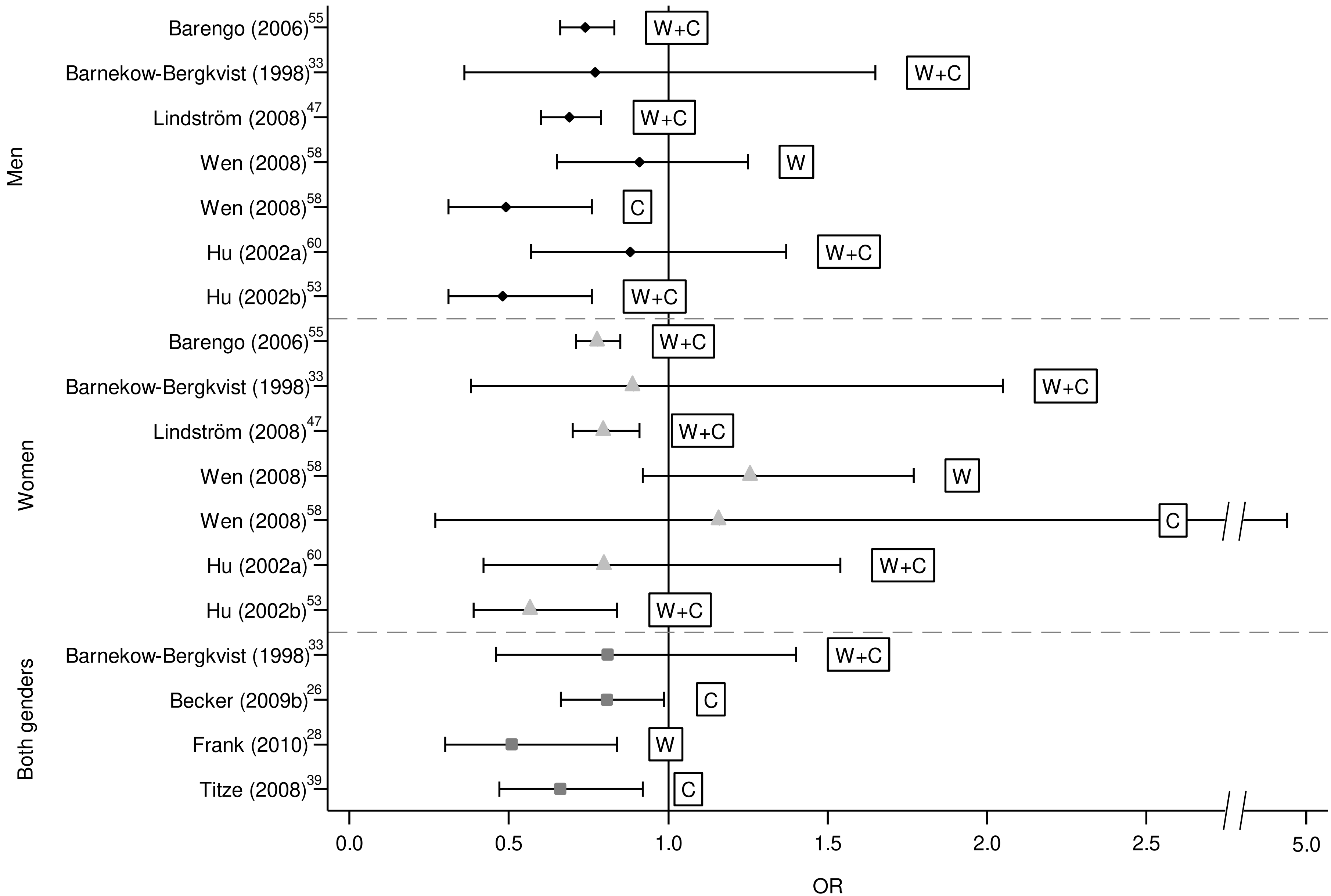
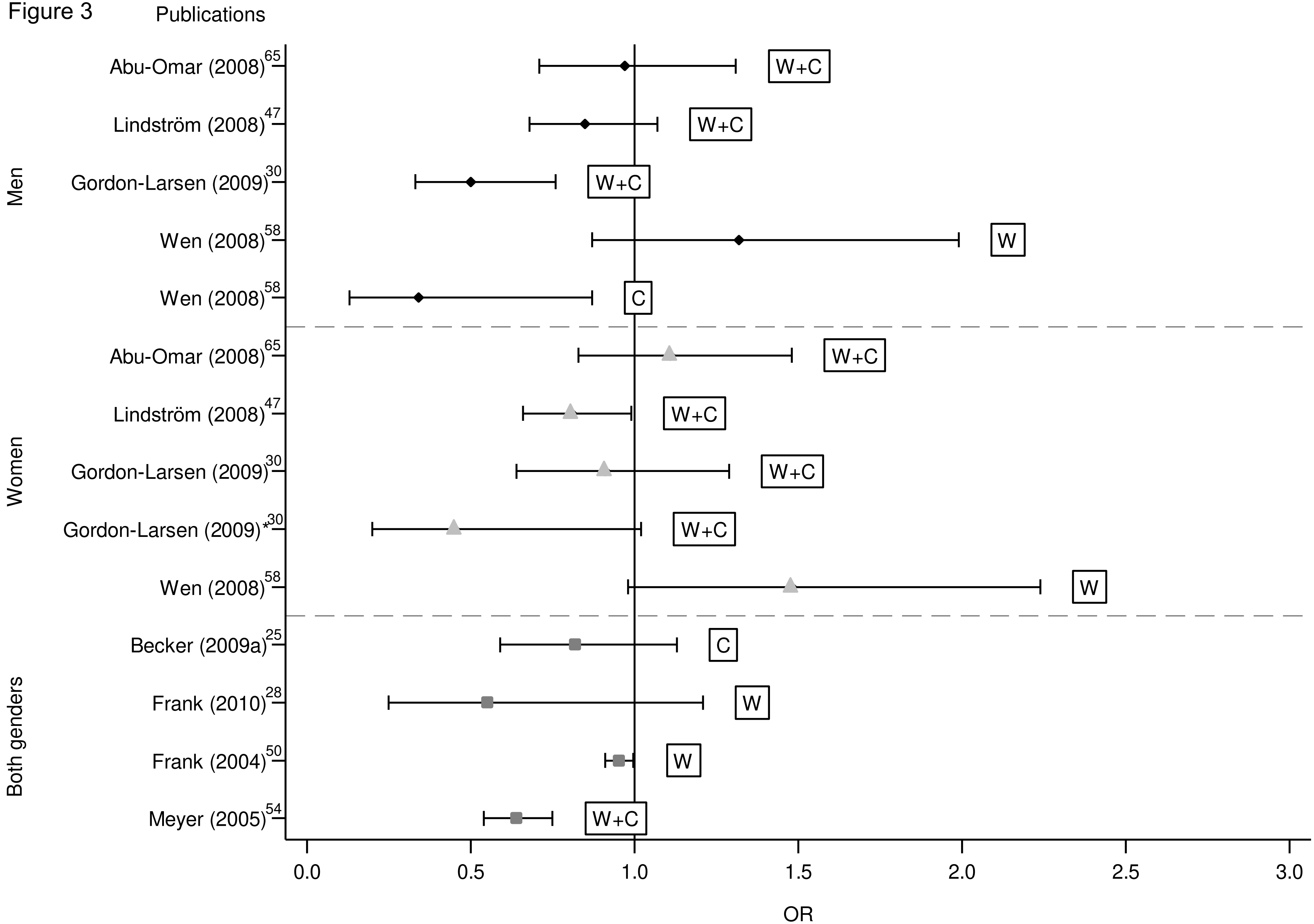

Publications
Men
Barengo (2006)55
Barnekow-Bergkvist (1998)33
Lindström (2008)47
Wen (2008)58
Wen (2008)58
Hu (2002a)60
Hu (2002b)53
Women
Barengo (2006)55
Barnekow-Bergkvist (1998)33
Lindström (2008)47
Wen (2008)58
Wen (2008)58
Hu (2002a)60
Hu (2002b)53
Both genders
Barnekow-Bergkvist (1998)33
Becker (2009b)26
Frank (2010)28
Titze (2008)39
W+C
W+C
W+C
W
C
W+C
W+C
W+C
W+C
W+C
W
C
W+C
W+C
W+C
C
W
C
0.0
0.5
1.0
1.5
2.0
2.5
5.0
OR

Figure 3


Publications
Men
Abu-Omar (2008)65
Lindström (2008)47
Gordon-Larsen (2009)30
Wen (2008)58
Wen (2008)58
Women
Abu-Omar (2008)65
Lindström (2008)47
Gordon-Larsen (2009)30
Gordon-Larsen (2009)*30
Wen (2008)58
Both genders
Becker (2009a)25
Frank (2010)28
Frank (2004)50
Meyer (2005)54
W+C
W+C
W+C
W
C
W+C
W+C
W+C
W+C
W
C
W
W
W+C
0.0
0.5
1.0
1.5
2.0
2.5
3.0
OR

Active Transport, Physical Activity Levels, and Body Weight in Adults

A Systematic Review

Miriam Wanner, PhD, Thomas Götschi, PhD, Eva Martin-Diener, MSc, MPH, Sonja Kahlmeier, PhD, Brian W. Martin, MD, MPH

Appendix A

Detailed description of included studies

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Europe								
Abu-Omar (2008)[1] 27 EU countries plus Croatia, Turkey, Cyprus North; 2005	29,193 NA NA ≥15	Self-report: BMI ≥30	Self-report (face-to-face interview): W+C ACT total Categories: a lot, some, little, none	Logistic regression: OR (95% CI)	—	Adjusted: OR for being obese (BMI ≥30) according to ACT category (ref is none): <u>Men:</u> OR_{little}=1.03 (0.78, 1.37), OR_{some}=1.15 (0.87, 1.52), $OR_{a\ lot}$=0.97 (0.71, 1.31); <u>Women:</u> OR_{little}=1.17 (0.91, 1.51), OR_{some}=1.22 (0.97, 1.57), $OR_{a\ lot}$=1.11 (0.83, 1.48)	Age, education, healthy diet, chronic illness, nationality, stratified by gender	5 (BW)
Barengo (2006)[2] Finland; 1982, 1987, 1992, 1997	28,782 13,832 14,950 25–64	Objectively measured: BMI ≥25, WC (men ≥94cm, women ≥80cm)	Self-report: W+C ACT work Categories: high (>30min/day), moderate (15-30min/day), low (<15min/day)	Logistic regression: OR (95% CI)	—	Adjusted: OR for being overweight (BMI ≥25) according to ACT category (ref is low): <u>Men:</u> OR_{mod}=0.80 (0.72, 0.90), OR_{high}=0.74 (0.66, 0.83); <u>Women:</u> OR_{mod}=0.78 (0.70, 0.86), OR_{high}=0.78 (0.71, 0.85); OR for having large WC (cut-off 94cm for men, 80cm for women) according to ACT category (ref is low): <u>Men:</u> OR_{mod}=0.98 (0.79, 1.21), OR_{high}=0.87 (0.69, 1.11); <u>Women:</u> OR_{mod}=0.90 (0.76, 1.08), OR_{high}=0.69 (0.58, 0.83)	Area, year of survey, age, education, smoking status, alcohol intake, LTPA, OPA; model for WC in addition: BMI; stratified by gender	7 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Barnekow-Bergkvist (1998)[3] Sweden; 1992	373 194 179 34	Self-report: BMI ≥25	Self-report: W+C ACT work Categories: ≥1d/week versus <1d/week	Logistic regression: OR (95% CI)	—	Adjusted: OR for being overweight (BMI ≥25) for ACT ≥1 day/week compared to <1 day/week: <u>Men:</u> OR=0.77 (0.36, 1.65); <u>Women:</u> OR=0.89 (0.38, 2.05); <u>Men and women combined:</u> OR=0.81 (0.46, 1.40)	Sociodemographic variables (marital status, children at home, education, SES); lifestyle variables (LTPA, smoking, smokeless tobacco use, breakfast, healthy food choices); gender; all same age	2 (BW)
Becker (2009a)[4] Germany; 2006 (same study as Becker (2009b[5]))	2002 982 1020 50–70	Self-report (CATI): exercising Categories: ≥1/week vs <1/week Self-report (CATI): BMI ≥30	Self-report (CATI): C only ACT total Categories: ≥1/week versus <1/week	Logistic regression: OR (95% CI)	Adjusted: OR for exercising (≥1/week) according to ACT category (ref is <1/week): $OR_{\geq 1/week}$=2.44 (1.99, 2.99)	Adjusted: OR for being obese (BMI ≥30) according to ACT category (ref is <1/week): $OR_{\geq 1/week}$=0.82 (0.59, 1.13)	<u>Association with PA:</u> education, tobacco use, eating habits, overweight, state of health, diabetes. <u>Association with weight:</u> age, gender, education, tobacco use, subjective state of health, diabetes, cholesterol, hypertension, current sporting activity	3 (PA) 4 (BW)
Becker (2009b)[5] Germany; 2006 (same study as Becker (2009a[4]))	2002 982 1020 50–70	Self-report (CATI): exercising Categories: ≥1/week vs <1/week Self-report (CATI): BMI ≥25	Self-report (CATI): C only ACT total Categories: ≥1/week versus <1/week	Logistic regression: OR (95% CI)	Adjusted: OR for exercising (≥1/week) according to ACT category (ref is <1/week): $OR_{\geq 1/week}$=2.53 (2.06, 3.09)	Adjusted: OR for being overweight (BMI ≥25) according to ACT category (ref is <1/week): $OR_{\geq 1/week}$=0.81 (0.66, 0.99)	<u>Association with PA:</u> education, tobacco use, eating habits, overweight, subjective state of health <u>Association with weight:</u> age, gender, education, tobacco use, subjective state of health, current sporting activity	3 (PA) 4 (BW)
Bovens (1993)[6] Netherlands; NA	2907 2009 898 ≥40	Objectively measured: BMI (continuous), % body fat	Self-report (interview): C only ACT total Categories: >1hour/week versus less	Pearson's correlation: *r*, significant if $p<0.05$	—	Unadjusted: ACT (>1 hour/week) and BMI: <u>Men:</u> r = −0.06 ($p<0.01$); <u>Women:</u> r =0.02 (NS); ACT (>1 hour/week) and % body fat: <u>Men:</u> r =0.01 (NS); <u>Women:</u> r =0.10 ($p<0.001$)	—	4 (BW)
Hu (2003)[7] Finland; 1982, 1987, 1992	14,290 6,898 7,392 35–64	Objectively measured: mean BMI, BMI ≥30	Self-report: W+C ACT work Categories: 0min/day, 1- 29min/day, ≥30min/day	ANOVA; significant if $p<0.05$	—	Adjusted: Prevalence of obesity (BMI ≥30) for different ACT categories: <u>Men:</u> 0 min/day: obesity=20.1%, 1–29 min/day: obesity=18.1%, ≥30 min/day: obesity=15.6% (*p* for trend=0.004); <u>Women:</u> 0 min/day: obesity=25.2%, 1– 29 min/day: obesity=17.6%, ≥30 min/day: obesity=15.8% (*p* for trend<0.001)	Age, study year, stratified by gender	6 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Kwasniewska (2010a)[8] Poland; 2002–2005; (same study as Kwasniewska (2010b))[9]	7280 3747 3533 20–74	Self-report: LTPA Categories: none, occasionally, 2–3 d/week, 4–7 d/week; OPA Categories: low, moderate, high	Self-report: W+C ACT work/school Categories: 0min/day, 1-14min/day, 15-29min/day, ≥30min/day	Logistic regression: OR (95% CI)	Unadjusted: OR for ACT (0 min/day) according to LTPA categories (ref is none): <u>Men:</u> $OR_{occaisonal}$=1.14 (0.78, 1.57), $OR_{2–3d/week}$=1.12 (1.16, 1.74), $OR_{4–7d/week}$=0.59 (0.44, 0.58); <u>Women:</u> $OR_{occasional}$=1.18 (1.01, 2.10), $OR_{2–3d/week}$=1.16 (1.02, 1.66), $OR_{4–7d/week}$=0.60 (0.43, 0.60). OR for commuting inactivity according to levels of OPA (ref is low OPA): <u>Men:</u> OR_{mod}=1.27 (1.14, 1.75), OR_{high}=0.40 (0.35, 0.50); <u>Women:</u> OR_{mod}=1.17 (1.00, 1.37), OR_{high}=0.29 (0.25, 0.34) Adjusted: OR for ACT (0 min/day) according to LTPA categories (ref is none): <u>Men:</u> $OR_{occasional}$=1.06 (0.83, 1.29), $OR_{2–3d/week}$=1.04 (0.82, 1.32), $OR_{4–7d/week}$=0.89 (0.74, 1.19); <u>Women:</u> $OR_{occasional}$=1.15 (0.94, 1.40), $OR_{2–3d/week}$=1.03 (0.82, 1.29), $OR_{4–7d/week}$=0.91 (0.68, 1.20). OR for commuting inactivity according to levels of OPA (ref is low OPA): <u>Men:</u> OR_{mod}=0.95 (0.77, 1.18), OR_{high}=0.52 (0.44, 0.62); <u>Women:</u> OR_{mod}=0.83 (0.69, 1.00), OR_{high}=0.44 (0.36, 0.53)		Age, education, place of residence, income, marital status, smoking, other domains of PA, stratified by gender	4 (PA)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Kwasniewska (2010b)[9] Poland; 2002–2005 (same study as Kwasniewska (2010a)[8])	6401 3297 3104 20–74	Objectively measured: mean BMI, WC (men ≥94cm, ≥102cm, women ≥80cm, ≥88cm)	Self-report: W+C ACT work/school Categories: yes/no 0min/day, 1-14min/day, 15-29min/day, ≥30min/day	M (SD): logistic regression: OR (95% CI)	—	Unadjusted: Mean BMI for active vs non-active commuters: <u>Men:</u> BMI_{act}=25.8 (4.3), $BMI_{non\text{-}act}$=26.4 (4.1) (p<0.05); <u>Women:</u> BMI_{act}=24.1 (4.6), $BMI_{non\text{-}act}$=24.9 (4.7) (p<0.05). Mean WC in cm for active vs non-active commuters: <u>Men:</u> WC_{act}=91.9 (11.1), $WC_{non\text{-}act}$=93.6 (11.2) (p<0.01); <u>Women:</u> WC_{act}=78.7 (11.9), $WC_{non\text{-}act}$=79.6 (11.8) (p<0.05) Adjusted: OR for WC according to ACT category (ref is 0min/day): <u>Men:</u> WC≥102cm: $OR_{1\text{-}14min/d}$=1.00 (0.78, 1.29), $OR_{15\text{-}29min/d}$=0.88 (0.64, 1.21), $OR_{\geq30min/d}$=0.68 (0.38, 1.25); WC≥94cm: $OR_{1\text{-}14min/d}$=0.79 (0.64, 0.98), $OR_{15\text{-}29min/d}$=0.81 (0.63, 1.06), $OR_{\geq30min/d}$=0.47 (0.29, 0.77); <u>Women:</u> WC≥88cm: $OR_{1\text{-}14min/d}$=0.92 (0.73, 1.15), $OR_{15\text{-}29min/d}$=1.02 (0.79, 1.33), $OR_{\geq30min/d}$=0.79 (0.48, 1.29); WC≥80cm: $OR_{1\text{-}14min/d}$=0.70 (0.58, 0.84), $OR_{15\text{-}29min/d}$=0.77 (0.62, 0.95), $OR_{\geq30min/d}$=0.69 (0.58, 0.89)	Age, education, place of residence, monthly income, smoking, alcohol consumption, calorie intake, LTPA, stratified by gender	6 (BW)
Lahti-Koski (2000)[10] Finland; 1987, 1992, 1997	15,096 7,233 7,863 25–64	Objectively measured: WHR	Self-report: W+C ACT work EE calculated	Linear regression: coefficient beta (SEM)	—	Adjusted: Effect of EE from ACT on WHR (coefficient for 1MJ of EE/day from ACT): Model 1: <u>Men:</u> beta=-0.00603+/−0.00229 (p=0.0084); <u>Women:</u> beta=-0.01682+/−0.00228 (p=0.0001). Model 2: <u>Men:</u> beta=-0.00276+/−0.00177 (p=0.19); <u>Women:</u> beta=-0.00925+/−0.00195 (p=0.0001)	<u>Model 1:</u> age, education level, alcohol consumption, smoking status, PA at work, LTPA, survey year, stratified by gender; <u>Model 2:</u> BMI in addition	8 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Lindström (2008)[11] Sweden; 2004	16,705 7,955 8,750 18–80	Self-report: BMI≥25, BMI≥30	Self-report: W+C ACT work Categories: Car, active (W+C), public transport, other	Logistic regression: OR (95% CI)	—	Unadjusted: OR for overweight (BMI ≥25) according to ACT category (ref is car): Men: OR_{W+C}=0.65 (0.58, 0.73), OR_{public}=0.58 (0.50, 0.68), OR_{other}=0.85 (0.66, 1.10); Women: OR_{W+C}=0.82 (0.74, 0.91), OR_{public}=0.96 (0.85, 1.08), OR_{other}=0.98 (0.73, 1.32). OR for obesity (BMI ≥30) according to ACT category (ref is car): Men: OR_{W+C}=0.77 (0.63, 0.93), OR_{public}=0.56 (0.43, 0.74), OR_{other}=0.83 (0.56, 1.24); Women: OR_{W+C}=0.79 (0.66, 0.94), OR_{public}=1.09 (0.90, 1.31), OR_{other}=1.31 (0.87, 1.99) Adjusted: OR for overweight (BMI≥25) according to ACT category (ref is car): Men: OR_{W+C}=0.69 (0.60, 0.79), OR_{public}=0.72 (0.61, 0.86), OR_{other}=0.96 (0.70, 1.30); Women: OR_{W+C}=0.80 (0.70, 0.91), OR_{public}=1.01 (0.87, 1.17), OR_{other}=0.93 (0.65, 1.34). OR for obesity (BMI≥30) according to ACT category (ref is car): Men: OR_{W+C}=0.85 (0.68, 1.07), OR_{public}=0.70 (0.51, 0.95), OR_{other}=1.01 (0.66, 1.61); Women: OR_{W+C}=0.81 (0.66, 0.99), OR_{public}=1.21 (0.96, 1.52), OR_{other}=1.43 (0.87, 2.36)	Age, country of origin, education, time for travel to work, stratified by gender	4 (BW)
Meyer (2005)[12] Switzerland; 2002	9171 5323 3848 ≥50	Self-report (CATI): BMI 25–30, BMI>30	Self-report (CATI): W+C ACT total Categories: Habitual PA (≥30min/day) versus less	Logistic regression: OR (95% CI)		Adjusted: OR for ACT (≥30min/day) according to BMI category (ref is BMI <25): $OR_{25–30}$=0.89 (0.80, 0.99); $OR_{>30}$=0.64 (0.54, 0.75)	Age, gender, income, residential, language region, different subjective health variables	3 (BW)
Molina-Garcia (2010)[13] Spain; 2009	518 40.3% 59.7% M: 22.4 (university students)	Self-report (GPAQ): general PA, EE calculated (MET-min/week)	Self-report: W+C ACT uni EE calculated (MET-min/week)	Correlation: *r*, significant if $p<0.05$	Unadjusted: EE from ACT and EE from total PA: r =0.06 (NS)			4 (PA)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Thommen Dombois (2007)[14] Switzerland; 2004	901 411 490 ≥18	Self-report: total PA (moderate and vigorous PA) Categories: meeting PA recommendations, not meeting PA recommendations	Self-report (interview): W+C ACT sep (ACT work, ACT other) Categories: active (W+C), passive (car, public transport, others)	Logistic regression: OR (95% CI)	Unadjusted: OR for not meeting PA recommendations according to ACT category (ref is active): to work $OR_{passive}$=1.98 (1.50, 2.62), shopping on weekdays $OR_{passive}$=1.35 (1.03, 1.77), shopping on weekends $OR_{passive}$=1.57 (1.20, 2.07), leisure activities on weekdays $OR_{passive}$=2.08 (1.58-2.75), leisure activities on weekends $OR_{passive}$=1.60 (1.21, 2.10) Adjusted: OR for not meeting PA recommendations according to ACT category (ref is active, all three communities): to work $OR_{passive}$=1.64 (1.10, 2.44), shopping on weekdays $OR_{passive}$=0.68 (0.44, 1.07), shopping on weekends $OR_{passive}$=1.29 (0.85, 1.94), leisure activities on weekdays $OR_{passive}$=1.92 (1.26, 2.92), leisure activities on weekends $OR_{passive}$=1.04 (0.68, 1.58)	—	Gender, age, hikes per month, community, location of home within community (center, outside)	2 (PA)
Titze (2008)[15] Austria; 2005	998 460 445 (gender probably not available for 93 participants) 15–60	Self-report (CATI): general PA Categories: inactive, moderately active, highly active Self-report (CATI): BMI>25	Self-report (CATI): C only ACT other Categories: cyclist (≥1/week), non-cyclist (<1/week)	Factor analysis: OR (95% CI)	Unadjusted: OR for being a cyclist (≥1/week) according to PA category (ref is inactive): OR_{mod}=0.82 (0.52, 1.30); OR_{high}=2.30 (1.59, 3.32)	Unadjusted: OR for being a cyclist (≥1/week) according to BMI category (ref is BMI ≤25): $OR_{BMI>25}$=0.66 (0.47, 0.92)	—	3 (PA) 3 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Van Dyck (2010)[16] Belgium; NA	1166 47.9% 52.1% 20–65	Self-report: BMI (continuous), objectively measured waist, WHER ratio calculated	Self-report (long IPAQ): W/C sep. ACT total Analyzed in min/week	Mediation models: regression coefficient (95% CI)	—	Adjusted: Coefficients of W and C with respect to BW: W and BMI: beta= –0.11 (–0.20, –0.03, *p*<0.05); C and BMI: beta= –0.20 (–0.26, –0.14, *p*<0.001); W and WHER: beta= –0.00124 (–0.00266, 0.000275, NS); C and WHER: beta= –0.00348 (–0.00500, –0.00229, *p*<0.001)	Age, working status, educational attainment, neighborhood SES, walkability; not stratified by gender	5 (BW)
von Huth Smith (2007)[17] Denmark; NA	6784 3302 3482 30–60	Objectively measured: BMI and WC (continuous)	Self-report: W+C ACT work Categories: <15min/day, 15-30min/day, 30-60min/day, ≥60min/day	Linear regression: coefficient beta (95% CI)	—	Adjusted: Proportional difference in BMI and WC according to ACT category (ref is ACT <15 min/day): BMI: 15–30 min/day: beta=0.98 (0.97, 0.99), 30–60 min/day: beta=0.99 (0.97, 0.99), ≥60 min/day: beta=0.97 (0.95, 0.99); WC: 15–30 min/day: beta=1.00 (0.99, 1.00), 30–60 min/day: beta=1.00 (0.99, 1.00), ≥60 min/day: beta=0.99 (0.98, 1.00)	Age, gender, smoking, alcohol intake, dietary fiber intake, energy percentage from saturated fat, BMI (only in models with WC), LTPA	5 (BW)
Wagner (2001)[18] France and Northern Ireland; baseline 1991-1993, follow-up after 5 years (same study as Wagner (2002)[19])	8865 8865 0 50–59 (at baseline)	Objectively measured at baseline: BMI and WC (continuous), self-report at follow-up: BMI	Self-report: W+C ACT work EE calculated (MET-hours/week)	Linear regression: coefficient beta (*p*-value)	—	Adjusted: cross-sectional (baseline): association between EE from ACT (MET h/week) and BMI: beta=-0.0310 (*p*<0.0001); association between EE from ACT (MET h/week) and WC: beta=-0.1027 (*p*<0.0001). Longitudinal: association between EE from ACT (MET h/week, at baseline) and changes in BMI over 5 years: beta=–0.0059 (*p*=0.04)	<u>Cross-sectional:</u> center, age group, marital status, educational level, socio-occupational class, following a weight control diet, alcohol and smoking habits, OPA; <u>longitudinal:</u> in addition initial BMI, changes in employment and smoking status	7 (BW CS objective BMI) 6 (BW LS self-report BMI)
Wagner (2002)[19] France and Northern Ireland; baseline 1991-1993, follow-up after 5 years (same study as Wagner (2001)[18])	9758 9758 0 50–59 (at baseline)	Objectively measured: mean BMI	Self-report: W+C ACT work Categories: walking or cycling to work (yes/no)	ANOVA: M (SD)	—	Unadjusted: Mean BMI according to ACT category: No ACT: mean BMI=26.7 (3.5); ACT: mean BMI=26.2 (3.3) (*p*<0.00001)	—	4 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Wennberg (2006)[20] Sweden; 1985	(baseline) 2681 2156 525 (but ACT data only assessed for 1708!) 30, 40, 50, and 60 (at baseline)	Objectively measured: mean BMI	Self-report: W+C ACT total (but including bus!) Categories: bus or walking or cycling every season, car 1-3 seasons, car every season	Kruskal-Wallis several independent test: M (*p*-value)	—	Unadjusted: Mean BMI according to ACT category: bus, W or C every season: mean BMI=25.3, car 1–3 seasons: mean BMI=25.7, car every season: mean BMI=26.1 (p<0.001)	—	4 (BW)
North America, Australia, New Zealand								
Badland (2004)[21] New Zealand; NA	56 27 29 25–45	Objectively measured: two pedometers for work, nonwork, and total step counts Categories (step count tertiles): low activity, moderate activity, high activity	Self-report: W+C ACT total Categories: Number of 30min blocks of ACT over 3 days: 0, 1-6, 7-10	Pearson's correlation: *r* (90% CI); logistic regression: OR (90% CI)	Unadjusted: ACT and total steps: r=0.43 (0.23, 0.59); ACT and nonwork pedometer values: r =0.34 (0.12, 0.52). OR for being in the high PA group according to ACT category (ref is no ACT): $OR_{ACT1\text{-}6}$=1.10 (0.29, 4.21), $OR_{ACT7\text{-}10}$=2.03 (0.94, 4.40)	—	—	4 (PA)
Badland (2008)[22] New Zealand; 2005	1989 48% 53% ≥16	Self-report (short IPAQ): total PA Categories: sufficiently active, not sufficiently active Self-report: BMI (being normal weight with different BMI cut-offs for different races)	Self-report (CATI): W+C ACT sep Categories: active (W+C), motorized	Logistic regression: OR (95% CI)	Unadjusted: OR for being sufficiently active according to ACT category (ref is W+C): to work/study: $OR_{motorized}$=0.5 (0.3, 0.9), to convenience shop: $OR_{motorized}$=1.0 (0.6, 1.5) Adjusted: OR for being sufficiently active according to ACT category (ref is W+C): to work/study: $OR_{motorized}$=0.5 (0.2, 0.9), to convenience shop: $OR_{motorized}$=0.9 (0.5, 1.5)	Unadjusted: OR for being normal weight according to ACT category (ref is W+C): to work/study: $OR_{motorized}$=0.6 (0.3, 0.9), to convenience shop: $OR_{motorized}$=0.9 (0.5, 1.3) Adjusted: OR for being normal weight according to ACT category (ref is W+C): to work/study: $OR_{motorized}$=0.5 (0.3, 0.9), to convenience shop: $OR_{motorized}$=1.0 (0.6, 1.6)	Gender, age, household income, education attainment	4 (PA) 3 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Boone-Heinonen (2009)[23] U.S.; 2005–2006 (same study as Gordon-Larsen (2009)[24])	2717 1172 1545 38–50	Self-report: PA other than W and C, PA score calculated Categories: high (above median), low (below median) Objectively measured: BMI and WC (continuous)	Self-report: W/C sep. ACT other (to different amenities) Categories: walk-only, any cycling	Multinomial logistic regression: OR (95% CI); linear regression: coefficient beta (95% CI)	Adjusted: OR for ACT (walk only (W) and any cycling (C) compared to car) according to PA category (ref is low PA): to recreational facility: W: OR_{high}=1.12 (0.73, 1.73), C: OR_{high}=1.52 (0.82, 2.82); to park: W: OR_{high}=1.07 (0.82, 1.40), C: OR_{high}=1.75 (1.24, 2.47); to grocery store: W: OR_{high}=0.99 (0.72, 1.36), C: OR_{high}=1.35 (0.87, 2.11); to fast-food restaurant: W: OR_{high}=1.39 (0.94, 2.05), C: OR_{high}=2.42 (1.24, 4.70); to sit down restaurant: W: OR_{high}=0.92 (0.67, 1.25), C: OR_{high}=1.70 (0.90, 3.21); to public transit: W: OR_{high}=1.31 (0.83, 2.06), C: OR_{high}=0.96 (0.39, 2.36)	Adjusted: BMI and WC as a function of walk-only (W) / any cycling (C) (ref is car-only): BMI: <u>Men</u> $beta_W$= –0.46 (–1.08, 0.17), $beta_C$=–0.34 (–1.12, 0.44); <u>Women:</u> $beta_W$=–0.62 (–1.33, 0.10), $beta_C$= –1.68 (–2.81, –0.55). WC: <u>Men:</u> $beta_W$= –1.63 (–3.18, –0.09), $beta_C$=–2.27 (–4.22, –0.32); <u>Women:</u> $beta_W$= –0.33 (–1.78, 1.11), $beta_C$= –3.41 (–5.71, –1.11)	<u>Association with PA:</u> gender, race, living with partner, living with young children, living with older children, education, income, employment, age, study center. <u>Association with BW:</u> age, race, education, household income, alcohol intake, smoking, PA other than walking, study center, stratified by gender	4 (PA) 5 (BW)
Butler (2007)[25] Canada; 2003	77,953 37,591 40,362 ≥15	Self-report (CATI): LTPA, EE calculated Categories: inactive, moderate, active	Self-report (CATI): W/C sep. ACT total Categories: cycling (yes/no), walking 6+ hours per week (yes/no)	Logistic regression: OR (95% CI)	Adjusted: OR for C according to PA category (ref is inactive): <u>Men:</u> OR_{mod}=1.93 (1.63, 2.29), OR_{act}=3.15 (2.71, 3.66); <u>Women:</u> OR_{mod}=1.80 (1.49, 2.20), OR_{act}=3.70 (3.12-4.40). OR for W 6+ hours according to PA category (ref is inactive): <u>Men:</u> OR_{mod}=0.96 (0.87, 1.05), OR_{act}=1.04 (0.94, 1.14); <u>Women:</u> OR_{mod}=1.25 (1.13, 1.38), OR_{act}=1.28 (1.16, 1.40)	—	Age category, marital status, working and student status, education, household income, immigrant status, region, urban/rural, smoking, typical daily activity (usually sitting, standing or walking, light carrying, heavy carrying), PA index (LTPA), stratified by gender	4 (PA)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Cleland (2010)[26] Australia; 2007–2008 (same study as MacFarlane (2009))[27]	4108 0 4108 (women with children, in disadvantaged neighborhoods) 18–45	Self-report: BMI categories (<25, 25–29.9, ≥30)	Self-report (IPAQ long): W+C ACT total Categories: 0-29min/week, 30-149min/week, ≥150min/week	Chi-square test: proportion (*p*-value)	—	Unadjusted: Proportion being normal weight (BMI<25) according to ACT category: 0–29 min/week: 28.2%, 30–149 min/week: 35.5%, ≥150 min/week: 36.3%. Proportion being overweight (BMI 25–29.9) according to ACT category: 0–29 min/week: 30.7%, 30–149 min/week: 33.6%, ≥150 min/week: 35.7%. Proportion being obese (BMI ≥30) according to ACT category: 0–29 min/week: 35.2%, 30–149 min/week: 33.9%, ≥150 min/week: 31.0% (0<0.01)	—	3 (BW)
Cole (2006)[28] Australia; 1996	3392 1664 1728 ≥18	Self-report: BMI categories (<18.5, 18.5–24.9, 25–29.9, ≥30)	Self-report (CATI) W only ACT total Categories: no walking, casual pace, moderate or brisk; and ≥150min/week versus <150min/week	Chi-square test: proportion; logistic regression: OR (95% CI)	—	Unadjusted: Significant association between ACT (moderate or brisk) and BMI categories (proportion of "no walking" higher in individuals with BMI ≥25, proportion of "brisk walking" higher in individuals with BMI 18.5–24.9) Adjusted: OR for sufficient ACT (≥150min/week) according to BMI category (ref is BMI<18.5): <u>Men:</u> $OR_{18.5–24.9}$=2.06 (0.28, 15.4), $OR_{25–29.9}$=1.37 (0.18-10.3), $OR_{\geq 30}$= 1. 30 (0.17, 10.3); <u>Women:</u> $OR_{18.5–24.9}$=1.54 (0.66,3.63), $OR_{25-29.9}$=0.85 (0.33, 2.19), $OR_{\geq 30}$=1.77 (0.67, 4.67)	Age group, education, paid work (yes/no), rural/urban, country of birth, stratified by gender	4 (BW)
Dunton (2009)[29] U.S.; 2006	10,984 4840 6144 ≥21	Self-report: BMI (continuous)	Self-report (CATI): W+C ACT total Categories: none (0min), some (≥1min)	Linear regression: coefficient beta (*p*-value)	—	Adjusted: BMI by time spent in ACT (ref is some): $beta_{none}$= 0.63 (*p*<0.0001); predicted marginal mean for BMI is 27.70 for none ACT and 27.07 for some ACT	Gender, age, education, race/ethnicity, self-reported health status	4 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Frank (2010)[30] U.S.; 2001–2002 (same study as Frank (2004)[31])	1970 861 1109 ≥65	Self-report: BMI≥25, BMI≥30	Self-report (2 day travel diary): W only ACT total Categories: walked at least once over the last 2 days versus did not walk at all	Chi-square test: proportion (*p*-value); logistic regression: OR (CI)	—	Unadjusted: Proportion with BM I ≥25: no walking trips: 56.4%, ≥1 walking trip: 48.8%; proportion with BMI ≥30: no walking trips: 18.7%, ≥1 walking trip: 15.1% (NS) Adjusted: OR for being overweight (BMI≥25) according to ACT (ref is no walking trip): $OR_{\geq once}$=0.51 (0.30, 0.84). OR for being obese (BMI ≥30) according to ACT (ref is no walking trip): $OR_{\geq once}$ =0.55 (0.25, 1.21)	Age, living alone, household income, number of cars in household, ethnicity, education, gender, walkability, time spent in a car, meeting the PA guidelines, grocery store trip, fast food trip	4 (BW)
Frank (2004)[31] U.S.; 2000–2002 (same study as Frank (2010))[30]	10,878 5013 5865 ≥16	Self-report: BMI≥30	Self-report (2 day travel diary): W only ACT total distance walked (km/d) calculated using GIS	Logistic regression: OR (95% CI)	—	Adjusted: OR for being obese (BMI ≥30) according to ACT (walk distance in km/day): OR=0.952 (0.910, 0.997)	Age, education, income, time spent in car, land-use mix, gender/ethnicity categories (black men/boys, black women/girls, white men/boys, white women/girls)	6 (BW)
Gordon-Larsen (2005)[32] U.S.; 2001–2002	10,771 49% 51% 18–28	Self-report: moderate and vigorous LTPA Categories: meeting PA recommendations, not meeting PA recommendations Objectively measured: BMI<25, BMI≥25	Self-report: W+C ACT work, ACT school Categories: active (W+C), public transport, car	Student's *t*-statistic with Bonferroni correction	Unadjusted: Active transit to work: Proportion W or C to work according to LTPA category: meeting PA recommendations: 15.2%, not meeting PA recommendations: 7.5% (p ≤0.01); full-time workers only: 12.5% vs 5.6% (p ≤0.01); part-time workers only: 21.8% vs 12.4% (NS). Active transit to school: Proportion W or C to school according to LTPA category: meeting PA recommendations: 37.0%, not meeting the PA recommendations: 25.6% (p ≤0.01); full-time students only: 44.7% vs 31.8% (p ≤0.01); part-time students only: 6.4% vs 3.7% (NS)	Unadjusted: Active transit to work: Proportion W or C to work according to BMI category: BMI <25: 9.2%, BMI ≥25: 6.8% (p ≤0.01); full-time workers only: 6.8% vs 5.4% (NS); part-time workers only: 14.6% vs 11.2% (NS). Active transit to school: Proportion W or C to school according to BMI category: BMI<25: 29.7%, BMI ≥25: 22.6% (p ≤0.01); full-time students only: 35.9% vs 28.9% (p ≤0.01); part-time students only: 4.3% vs 3.5% (NS)	—	2 (PA) 4 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Gordon-Larsen (2009)[24] U.S.; 2005–2006 (same study as Boone-Heinonen (2009)[23])	2364 1065 1299 38–50	Objectively measured: Accelerometer, Categories: meeting recommendations for moderate PA (<24 min/day vs ≥24.1 min/day), (excluding individuals meeting recommendations for vigorous PA) Self-report: leisure walking Categories: none, intermittent, regular; Total PA score (excluding walking) in tertiles) Objectively measured: BMI (continuous), BMI≥30	Self-report: W+C ACT work, defined as any walking or cycling during trip from home to work	Proportion (*p*-value); logistic regression: OR (95% CI)	Unadjusted: Proportion in different tertiles of PA score according to ACT <u>Men:</u> no ACT: low PA=29.7%, medium PA=35.9%, high PA=34.5%; ACT: low PA=28.1%, medium PA=33.3%, high PA=38.5% (NS); <u>Women:</u> no ACT: low PA=31.1%, medium PA=35.3%, high PA=33.6%; ACT: low PA=24.1%, medium PA=30.0%, high PA=45.8% ($p<0.05$) Adjusted: OR for ACT according to self-report leisure walking (ref is none): Men: $OR_{intermittent}$=1.96 (1.25, 3. 08), $OR_{regular}$=3.26 (1.95, 5.43); <u>Women:</u> $OR_{intermittent}$=2.82 (1.64, 4.86), $OR_{regular}$=5.62 (3.10, 10.18). OR for ACT according to meeting recommendations for moderate PA based on accelerometer data (ref is not meeting recommendations): <u>Men:</u> OR=1.16 (0.71, 1.90); <u>Women:</u> OR=1.83 (1.25, 2.69)	Adjusted: OR for being obese (BMI ≥30) according to ACT (ref is no ACT): <u>Men:</u> OR=0.50 (0.33, 0.76); <u>Women:</u> OR=0.91 (0.64, 1.29), if limiting to those living within 2 miles of work location OR=0.45 (0.20, 1.02)	<u>Association with PA:</u> age, race, income, education, examination center, stratified by gender; <u>association with BW:</u> in addition: smoking, alcohol consumption, PA index excluding walking (self-report)	5 (PA Acc) 4 (PA val. quest.) 5 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Kruger (2008)[33] U.S.; 2005 (same study as Kruger (2009)[34])	31,482 13,762 17,666 ≥18	Self-report: BMI categories (<25, 25–29.9, ≥30)	Self-report: W only ACT total Categories: regularly active if walking ≥5 d/week for ≥30min each day)	Prevalence (95% CI)	—	Unadjusted: Prevalence of W for transportation according to different BMI categories: <u>Men:</u> BMI<25: 32.4% (30.6%, 34.2%), BMI 25–29.9: 30.5% (29.0%, 32.1%), BMI ≥30: 27.8% (25.8%, 29.9%); <u>Women:</u> BMI<25: 29.7% (28.3%, 31.2%), BMI 25–29.9: 24.8% (23.1%, 26.5%), BMI≥30: 22.7% (21.1%, 24.3%)	—	4 (BW)
Kruger (2009)[34] U.S.; 2005 (same study as Kruger (2008)[33])	13,480 5,711 7,769 ≥50	Self-report: BMI 25–29.9, BMI≥30	Self-report: W only ACT total Categories: regularly active if walking ≥5 d/week for ≥30min each day versus less	Logistic regression: OR (95% CI)	—	Adjusted: OR for overweight (BMI 25-29.9) according to ACT (ref is regularly active): <u>Overall:</u> OR=1.37 (1.07, 1.75); <u>Men:</u> OR=1.42 (1.02, 1.97); <u>Women:</u> OR=1.36 (0.94, 1.98). OR for obesity (BMI≥30) according to ACT (ref is regularly active): <u>Overall:</u> OR=1.47 (1.10, 1.96); <u>Men:</u> OR=1.46 (0.95, 2.2 7); <u>Women:</u> OR=1.50 (1.02, 2.23)	Age, race/ethnicity, education level, family income, self-rated health, disability status, smoking, alcohol intake, fruit and vegetable intake, LTPA, walking for leisure, strength training, gender (in models including all individuals) or stratified by gender	5 (BW)
MacFarlane (2009)[27] Australia; 2007–2008 (same study as Cleland (2010)[26])	1680 0 1680 (women with children in disadvantage d neighborhood s 18–46	Self-report: BMI categories (<25, 25–29.99, ≥30)	Self-report (based on IPAQ long): W+C ACT total Categories: tertiles (low, medium, and high)	Ordinal regression: OR (95% CI)	—	Unadjusted: Frequency of ACT according to BMI category: BMI <25: low : 31.4%, medium: 33.0%, high: 35.6%; BMI 25–29.99: low: 32.8%, medium: 30.7%, high: 36.5%; BMI ≥30: low: 37.6%, medium: 32.5%, high: 29.8% (*p*=0.016) Adjusted: OR predicting BMI from ACT (ref is low ACT): OR_{medium}=1.00 (0.81, 1.24), OR_{high}=1.03 (0.87, 1.22)	Age, born in Australia, English spoken at home, marital status, maternal education, partner's education, maternal employment status, maternal income, household income, age of child, LTPA, sitting time, soft drink intake, having disability/illness that affects PA, typical week regarding PA performance, clustering by suburb	3 (BW)
Scott (2009)[35] U.S.; 2004–2005	1815 NA NA Adults	Self-report: BMI (continuous)	Self-report: W only ACT total Categories: frequency per week (utilitarian walking)	Two-level weighted hierarchic linear models: coefficient (*p*-value)	—	Adjusted: Differences in utilitarian walking: estimate for BMI (as explanatory variable): <u>Whites:</u> $beta_{BMI}$= −0. 01 (*p*=0.18); <u>African Americans:</u> $beta_{BMI}$= −0.01 (*p*<0.01); differences in BMI: estimate for frequency of utilitarian walking (as explanatory variable): <u>Whites:</u> $beta_{ACT}$=0.0002 (*p*=0.94); <u>African Americans:</u> $beta_{ACT}$= −0.01 (*p*=0.05)	Site, age, gender, income, access to car in household, number of parks within 1 mile, number of markets within 1 mile, alpha index, street density, median block length, neighborhood SES index, safety feeling in neighborhood	5 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Sugiyama (2010)[36] Australia; 2003–2004	1408 38% 62% 20–65	Self-report (IPAQ long): LTPA mean min/day, OPA mean min/day Self-report: Mean BMI	Self-report: W+C ACT total Categories: habitual transport behavior: inactive, occasionally active, regularly active; W+C last week (based on IPAQ long): <5min/day, 5-25min/day, ≥25min/day	M (SD); general linear regression: adjusted M (95% CI)	Unadjusted: Mean min/day in LTPA according to different categories of habitual transport behavior: inactive: mean LTPA=27.8 (44.6), occasionally active: mean LTPA=40.8 (56.1), regularly active: mean LTPA=43.2 (53.8) (*p*<0.001); mean min/day in OPA according to different categories of habitual transport behavior: inactive: mean OPA=103.5 (164.1), occasionally active: mean OPA=97.9 (169.0), regularly active: mean OPA=106.9 (179.2) (NS)	Unadjusted: Mean BMI according to different categories of habitual transport behavior: inactive: mean BMI=26.6 (5.2), occasionally active: mean BMI=25.7 (4.5), regularly active: mean BMI=24.9 (4.6) (*p*<0.001) Adjusted: Mean BMI for different categories of habitual transport behavior: inactive: mean BMI=26.5 (26.1, 26.9), occasionally active: mean BMI=25.9 (25.5, 26.3), regularly active: mean BMI=25.1 (24.6, 25.6) (*p*<0.001); mean BMI for different categories of W+C in previous week: <5 min/day: mean BMI=25.7 (25.2, 26.2), 5–25 min/day: mean BMI =25.8 (25.4, 26.3), >25 min/day: mean BMI=26.0 (25.5, 26.4) (NS)	Age, gender, education, income, TV viewing, LTPA; habitual transport and W+C for transport in previous week, respectively	5 (PA) 4 (BW)
Wen (2006)[37] Australia; 2003 (same study as Wen (2008)[38])	6810 56.5% 43.5% ≥16	Self-report: total PA (MVPA, walking) Categories: meeting PA recommend-dations, not meeting PA recommend-dations Self-report: BMI<25, BMI≥25	Self-report: W+C (incl. public transport!) ACT work Categories: drivers, non-drivers; Subsample: frequency of car use: <6/week, 6-10/week, >10/week	Pearson's qui-square test: proportion (*p*-value); Mantel-Haenszel trend test: proportion (*p*-value); logistic regression: CI (95% CI)	Unadjusted: Prevalence of achieving PA recommendations significantly lower in drivers than in nondrivers (44.3% vs 56.3%, *p*<0.0001)	Unadjusted: Prevalence of BMI ≥25 significantly higher in drivers than in nondrivers (50.9% vs 43.3%); prevalence of BMI ≥25 significantly higher in more-frequent car users than in less-frequent car users (47% if car use frequency >10/week, 41% if 6–10/week, and 30% if <6 /week (*p* for trend=0.012) Adjusted: OR for being overweight or obese (BMI ≥25) if driving a car to work (ref is other modes of transport): OR_{car}=1.13 (1.01, 1.27, *p*=0.047)	Gender, age group, marital status, educational level, language spoken at home, level of PA, SES index for areas	3 (PA) 3 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Wen (2008)[38] Australia; 2003 (same study as Wen (2006)[37])	6810 3810 3022 ≥16	Self-report: BMI≥25, BMI≥30	Self-report: W/C sep. ACT work Categories (usual mode): W, C, driving, public transport, work at home	Logistic regression: OR (95% CI)	—	Adjusted: OR for being overweight or obese (BMI≥25) according to categories of ACT (ref is driving): <u>Men:</u> $OR_{walking}$=0.91 (0.65, 1.25), $OR_{cycling}$=0.49 (0.31, 0.76); <u>Women:</u> $OR_{walking}$=1.26 (0.92, 1.77), $OR_{cycling}$=1.16 (0.27, 4.94); OR for being obese (BMI ≥30) according to ACT (ref is driving): <u>Men:</u> $OR_{walking}$=1.32 (0.87,1.99), $OR_{cycling}$=0.34 (0.13, 0.87); <u>Women</u>: $OR_{walking}$=1.48 (0.98, 2.24), $OR_{cycling}$ -=not applicable (no women who were obese cycled to work)	Level of PA, age group, marital status, level of education, main language spoken at home, stratified by gender	4 (BW)
Other countries								
Forrest (2001)[39] Nigeria; 1992	799 498 301 20–64	Objectively measured: BMI, WC, HC (all continuous), WHR	Self-report (in-person interview): W+C ACT work Time spent in ACT work	Spearman rank order correlation: *r* (*p*-value); multiple regression: coefficient beta (*p*-value)	—	Unadjusted: <u>Men:</u> ACT and BMI: *r* = −0.34 (*p*<0.001), ACT and waist girth: *r* = −0.32 (*p*<0.001), ACT and hip girth: *r* = −0.31 (*p*<0.001), ACT and WHR: *r* = −0.18 (*p*<0.001); <u>Women:</u> ACT and BMI: *r* = −0.16 (p<0.01), ACT and waist girth: *r* = −0.14 (*p*<0.05), ACT and hip girth: *r* = −0.18 (*p*<0.01), ACT and WHR: *r* = −0.03 (NS) Adjusted: Association between ACT and BMI/waist girth: <u>Men:</u> ACT and BMI: beta= −0.25 (*p*<0.001), ACT and waist girth: beta= −0.18 (*p*<0.001); <u>Women:</u> ACT and BMI: beta= −0.02 (*p*=0.772), ACT and waist girth: beta= −0.01 (*p*=0.614)	Age, total caloric intake, insulin levels, stratified by gender	6 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Gomez (2005)[40] Columbia; 2002	1464 650 814 18–29	Self-report (IPAQ long): LTPA Categories: regular (meeting PA recommend-ations), irregular (some PA), inactive (no PA)	Self-report: W/C sep. ACT total W categories: regular or irregular (≥90min/week) versus less, C categories: regular or irregular versus inactive	Logistic regression: OR (95% CI)	Unadjusted: OR for bicycling (reg or irreg compared to inactive) related to LTPA (ref is inactive PA): $OR_{irregPA}$=2.62 (1.85, 3.70), OR_{regPA}=1.76 (1.01, 3.07). OR for walking (reg or irreg compared to inactive) related to PA (ref is inactive PA): $OR_{irregPA}$=1.25 (0.95, 1.66), OR_{regPA}=2.73 (1.57, 4.75) Adjusted: OR for bicycling (reg or irreg compared to inactive) related to LTPA (ref is inactive PA): $OR_{irregPA}$=1.84 (1.26, 2.69), OR_{regPA}=1.10 (0.60, 2.02). OR for walking (reg or irreg compared to inactive) related to PA (ref is inactive PA): $OR_{irregPA}$=1.25 (0.93, 1.67), OR_{regPA}=2.70 (1.52, 4.81)		Age, gender, marital status, education level, principal activity during last 30 days, self-perceived health, urban locality, neighborhood SES, use of ciclovia for recreation	5 (PA)
Hu (2002a)[41] China; 1996 (same study as Hu (2002c)[42])	3976 2002 1974 15–69	Objectively measured: mean BMI, BMI≥25	Self-report: W+C ACT total Categories: 0min/day, 1-30min/day, 31-60min/day, >60min/day	General factorial ANOVA: mean(*p*-value); logistic regression: OR (95% CI)	—	Adjusted: mean BMI according to ACT category: <u>Men:</u> 0 min: BMI=23.8, 1–30 min: BMI=23.0, 31–60 min: BMI=23.3, >60 min: BMI=23.2 (*p* for trend<0.05); <u>Women:</u> 0 min: BMI=23.5, 1–30 min: BMI=23.2, 31–60 min: BMI=23.5, >60 min: BMI=22.6 (*p* for trend<0.05). OR for being overweight (BMI ≥25) according to ACT category (ref is 0 min): <u>Men:</u> $OR_{1–30\ min}$=0.70 (0.49, 0.99), $OR_{31–60min}$=0.84 (0.58, 1.22), $OR_{>60min}$=0.88 (0.57, 1.37); <u>Women:</u> $OR_{1–30min}$=0.86 (0.50, 1.48), $OR_{31-60min}$=1.03 (0.60, 1.80), $OR_{>60min}$=0.80 (0.42, 1.54)	Age, education, smoking, alcohol consumption, OPA, stratified by gender	6 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Hu (2002b)[43] China; 1989	1205 601 604 25–64	Objectively measured: BMI ≥25	Self-report: W+C ACT total Categories: by bus, W <30min/day or C <15min/day, W ≥30min/day or C ≥15min/day	Logistic regression: OR (95% CI)	—	Adjusted: OR for being overweight (BMI≥25) according to ACT category (ref is by bus): <u>Men:</u> $OR_{W<30min/d-C<15min/d}$=0.50 (0.29, 0.80), $OR_{W\geq30min/d-C\geq15min/d}$=0.48 (0.31, 0.76), *p* for trend <0.01; <u>Women:</u> $OR_{W<30min/d-C<15min/d}$=1.32 (0.89, 1.96), $OR_{W\geq30min/d-C\geq15min/d}$=0.57 (0.39, 0.84), *p* for trend <0.001	Age, education, income, marital status, occupation, time of survey, stratified by gender	6 (BW)
Hu (2002c)[42] China; 1996 (same study as Hu (2002a)[41])	3976 2002 1974 15–69	Self-report: LTPA and exercise (times/month and duration) Categories: doing vs not doing	Self-report: W+C ACT total Categories: 0min/day, 1-30min/day, 31-60min/day, >60min/day	Logistic regression: OR (95% CI)	Adjusted: OR for LTPA according to ACT category (ref is 0 min/day): <u>Men:</u> $OR_{1-30min/day}$=2.52 (1.67, 3.81), $OR_{31-60min/day}$=3.06 (2.00, 4.69), $OR_{>60\ min/day}$=3.14 (1.94, 5.07), *p* for trend <0.001; <u>Women:</u> $OR_{1-30min/day}$=1.39 (0.76, 2.53), $OR_{31-60min/day}$=1.62 (0.88, 2.96), $OR_{>60min/day}$=2.08 (1.05, 4.10), *p* for trend<0.001	—	Age, education, income, marital status, occupation, stratified by gender	4 (PA)
Jurj (2007)[44] China; 1997–2000 (same study as Lee (2007)[45])	74,942 0 74,942 40–70	Objectively measured: BMI categories (<24, 24–27.9, ≥28, (Chinese standards))	Self-report: W+C ACT sep. EE calculated (MET-hours/week) and dichotomized at median	Logistic regression: OR (99% CI)	—	Adjusted: OR for ACT work according to BMI category (ref is BMI<24): $OR_{BMI24-27.9}$=1.08 (1.04, 1.14), $OR_{BMI\geq28}$=0.99 (0.91, 1.07). OR for ACT other according to BMI category (ref is BMI<24): $OR_{BMI24-27.9}$=1.06 (1.03, 1.10), $OR_{BMI\geq28}$=1.07 (1.01, 1.12)	Age, menopausal status, marital status, education, occupation, employment status, family income, family size, chronic disease, smoking, regular alcohol consumption, regular tea consumption, regular ginseng intake, TV watching, total dietary energy intake	6 (BW)

Study, place, year of assessment	N, *n* (men), *n* (women), age (years)	Measures of physical activity and weight variables	Measures of active transport	Statistical analyses	Association of active transport with general physical activity	Association of active transport with weight variables	Adjusted for	Quality scores
Lee (2007)[45] China; NA (same study as Jurj (2007)[44])	61,582 61,582 0 40–74	Objectively measured: BMI categories (<18.5, 18.5–24.9, 25–29.9, ≥30); WHR (in quartiles): Q1: <0.863, Q2: 0.863–0.899, Q3: 0.900–0.935, Q4: ≥0.936	Self-report: W+C ACT sep. EE calculated (MET-hours/week) and dichotomized at median	Logistic regression: OR (95% CI)	—	Adjusted: OR for ACT work according to BMI category (ref is BMI<18.5): $OR_{BMI18.5–24.9}$=0.93 (0.88, 0.99), $OR_{BMI25.0–29.9}$=0.85 (0.80, 0.91), $OR_{BMI\geq30}$=0.74 (0.69, 0.79). OR for ACT other according to BMI category (ref is BMI<18.5): $OR_{BMI18.5–24.9}$=1.02 (0.93, 1.12), $OR_{BMI25.0–29.9}$=1.01 (0.92, 1.12), $OR_{BMI\geq30}$=0.91 (0.79, 1.05). OR for ACT work according to quartiles of WHR (ref is Q1): OR_{Q2}=1.00 (0.95, 1.05), OR_{Q3}=0.99 (0.94, 1.04), OR_{Q4}=0.90 (0.85, 0.95)	Age, education, income per capita, occupation, family size, history of chronic diseases, smoking, alcohol consumption, tea consumption, ginseng intake, total dietary energy intake	6 (BW)
Rombaldi (2010)[46] Brazil; NA	972 418 554 20–69	Self-report (IPAQ long): LTPA Number of min/week (VPA with factor 2) Categories: insufficient PA (<150 min/week), sufficient PA (≥150 min/week) OPA Number of min/week (VPA with factor 2)	Self-report (based on IPAQ long): W+C ACT total Number of min/week Categories: 0min/week, 1-149min/week, ≥150min/week	Spearman correlation: *r* (*p*-value); logistic regression: OR (95% CI)	Unadjusted: ACT and LTPA: r =0.11 (p<0.001), ACT and OPA r =0.18 (p<0.01). Prevalence of insufficient LTPA according to ACT: 0 min/week: prevalence=73.9%, 1–149 min/week: prevalence=75.3%, ≥150 min/week: prevalence=64.7% (p=0.003) Adjusted: OR for insufficient LTPA according to ACT categories (ref is 0 min/week): $OR_{1–149min/week}$=1.01 (0.66, 1.54), $OR_{\geq150min/week}$=0.60 (0.40, 0.91)		Gender, age, skin color, BMI, self-rated health	4 (PA)

Note: All studies are cross-sectional, except for References 18 (longitudinal); and 19 and 20 (longitudinal, but only cross-sectional results are reported here).

ACT, active transport; ACT other, active transport for other purposes; ACT school, active transport to school (only active transport to school assessed/analyzed); ACT sep, total active transport assessed but analyzed separately for commuting to work and active transport for other purposes (e.g., for daily errands); ACT total, total active transport assessed and analyzed together; ACT uni, active transport to university (only active transport to university assessed/analyzed); ACT work, transport to work (only active commuting to work assessed/analyzed); BW, body weight; C, cycling; CATI, computer-assisted telephone interview; d, day; EE, energy expenditure; EU, European Union; HC, hip circumference; irreg, irregular; LTPA, leisure-time physical activity; M, mean, MJ, mega joule; mod, moderate; NA, not available; NS, not significant; OPA, occupational physical activity; PA, physical activity; Q, quartile; reg, regular; SEM, SE of the mean; SES, socio-economic status; W, walking; W+C, walking and cycling analyzed together; W/C sep, walking and cycling analyzed separately; WC, waist circumference; WHR, waist-to-hip ratio; WHER, waist-to-height ratio

Appendix B

Quality scores for studies reporting associations between active transport and physical activity

Publications	Study type	Assessment of exposure (active transport)	Assessment of physical activity as outcome	Sample size	Complete-ness of data	Control for confounding	Total score
Europe							
Becker (2009a)[4]	0	1	0	1	1	0	3
Becker (2009b)[5]	0	1	0	1	1	0	3
Kwasniewska (2010a)[8]	0	1	0	1	1	1	4
Molina-Garcia (2010)[13]	0	2	1	1	0	0	4
Thommen Dombois (2007)[14]	0	0	0	1	1	0	2
Titze (2008)[15]	0	1	0	1	1	0	3
North America, Australia, New Zealand							
Badland (2004)[21]	0	1	2	0	1	0	4
Badland (2008)[22]	0	0	1	1	1	1	4
Boone-Heinonen (2009)[23]	0	1	1	1	0	1	4
Butler (2007)[25]	0	1	0	2	0	1	4
Gordon-Larsen (2005)[32]	0	0	0	2	0	0	2
Gordon-Larsen (2009)[24]	0	0	2	1	1	1	5
Gordon-Larsen (2009)[24]	0	0	1	1	1	1	4
Sugiyama (2010)[36]	0	1	1	1	1	1	5
Wen (2006)[37]	0	0	0	1	1	1	3
Other countries							
Gomez (2005)[40]	0	1	1	1	1	1	5
Hu (2002c)[42]	0	1	0	1	1	1	4
Rombaldi (2010)[46]	0	1	1	1	1	0	4

Appendix C

Quality scores for studies reporting associations between active transport and body weight

Publications	Study type	Assessment of exposure (active transport)	Assessment of body weight as outcome	Sample size	Completeness of data	Control for confounding	Total score
Europe							
Abu-Omar (2008)[1]	0	1	0	2	1	1	5
Barengo (2006)[2]	0	1	2	2	1	1	7
Barnekow-Bergkvist (1998)[3]	0	0	0	0	1	1	2
Becker (2009a)[4]	0	1	0	1	1	1	4
Becker (2009b)[5]	0	1	0	1	1	1	4
Bovens (1993)[6]	0	1	2	1	0	0	4
Hu (2003)[7]	0	1	2	2	1	0	6
Kwasniewska (2010b)[9]	0	1	2	1	1	1	6
Lahti-Koski (2000)[10]	0	2	2	2	1	1	8
Lindström (2008)[11]	0	0	0	2	1	1	4
Meyer (2005)[12]	0	0	0	1	1	1	3
Titze (2008)[15]	0	1	0	1	1	0	3
Van Dyck (2010)[16]	0	3	0	1	1	0	5
von Huth Smith (2007)[17]	0	1	2	1	1	0	5
Wagner (2001)[18]	0	2	2	1	1	1	7
Wagner (2001)[18]	1	2	0	1	1	1	6
Wagner (2002)[19]	0	0	2	1	1	0	4
Wennberg (2006)[20]	0	0	2	1	1	0	4
North America, Australia, New Zealand							
Badland (2008)[22]	0	0	0	1	1	1	3
Boone-Heinonen (2009)[23]	0	1	2	1	0	1	5
Cleland (2010)[26]	0	1	0	1	1	0	3
Cole (2006)[28]	0	1	0	1	1	1	4
Dunton (2009)[29]	0	0	0	2	1	1	4
Frank (2010)[30]	0	1	0	1	1	1	4
Frank (2004)[31]	0	3	0	2	0	1	6
Gordon-Larsen (2005)[32]	0	0	2	2	0	0	4
Gordon-Larsen (2009)[24]	0	0	2	1	1	1	5
Kruger (2008)[33]	0	1	0	2	1	0	4
Kruger (2009)[34]	0	1	0	2	1	1	5
MacFarlane (2009)[27]	0	1	0	1	0	1	3
Scott (2009)[35]	0	3	0	1	0	1	5
Sugiyama (2010)[36]	0	1	0	1	1	1	4
Wen (2006)[37]	0	0	0	1	1	1	3
Wen (2008)[38]	0	1	0	1	1	1	4
Other countries							
Forrest (2001)[39]	0	2	2	1	1	0	6
Hu (2002a)[41]	0	1	2	1	1	1	6
Hu (2002b)[43]	0	1	2	1	1	1	6
Jurj (2007)[44]	0	0	2	2	1	1	6
Lee (2007)[45]	0	0	2	2	1	1	6

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